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Peinovich et al.

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(54) **POSITIONING APPARATUS**

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H01L 21/687	(2006.01)
H01L 21/677	(2006.01)
H01L 21/67	(2006.01)

(52) **U.S. Cl.**

CPC ***H01L 21/68*** (2013.01); ***H01L 21/67766*** (2013.01); ***H01L 21/67778*** (2013.01); ***H01L 21/68707*** (2013.01); *H01L 21/67259* (2013.01); *Y10T 29/49998* (2015.01)

(58) **Field of Classification Search**

CPC B23Q 3/18; H01L 21/68707; H01L 21/68; H01L 21/67778; H01L 21/67766; H01L 21/67259; H01L 21/67776; H01L 21/681; C23C 14/56; C23C 16/52; C23C 16/54; Y10S 414/137; Y10S 414/135; Y10S 414/141; B25J 9/042; Y10T 29/49998

USPC 269/55, 56, 21; 156/345.31–345.32; 118/668, 719

See application file for complete search history.

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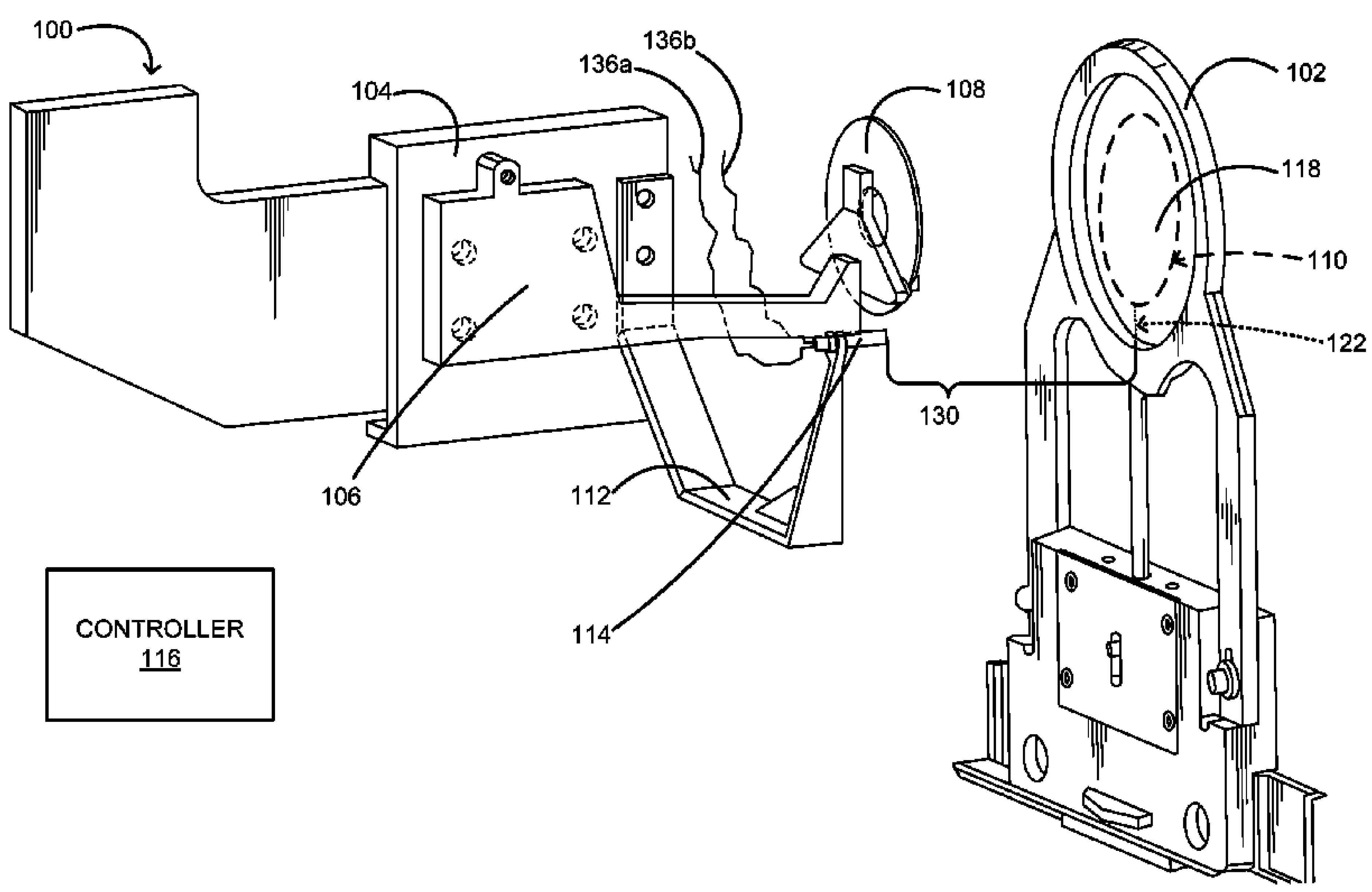
Assistant Examiner — Mahdi H Nejad

(57) **ABSTRACT**

Provided herein is an apparatus including a loader configured to position a workpiece in a holding fixture. In some embodiments, the holding fixture includes an opening configured to removably receive the workpiece therein and hold the workpiece in a target position within the opening. The apparatus also includes position detecting means configured to translate a sensor to a predetermined location relative to the holding fixture and further configured to translate the workpiece by a predetermined increment relative to the predetermined location to position the workpiece in the target position.

14 Claims, 11 Drawing Sheets



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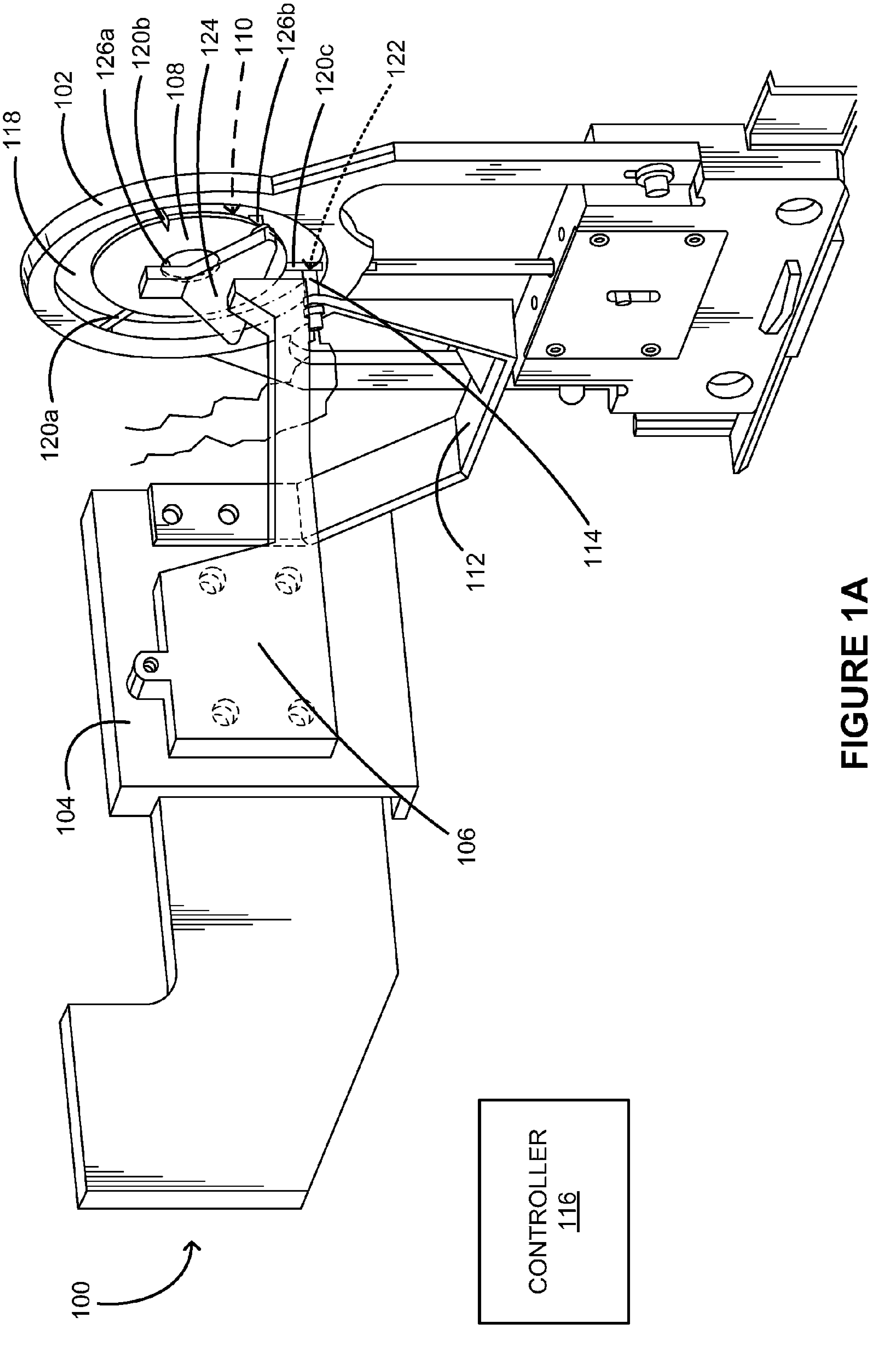
118
102
126a
120b
108
124
110
126b
120c
122
120a
104
106
112
114
100
CONTROLLER
116

FIGURE 1A

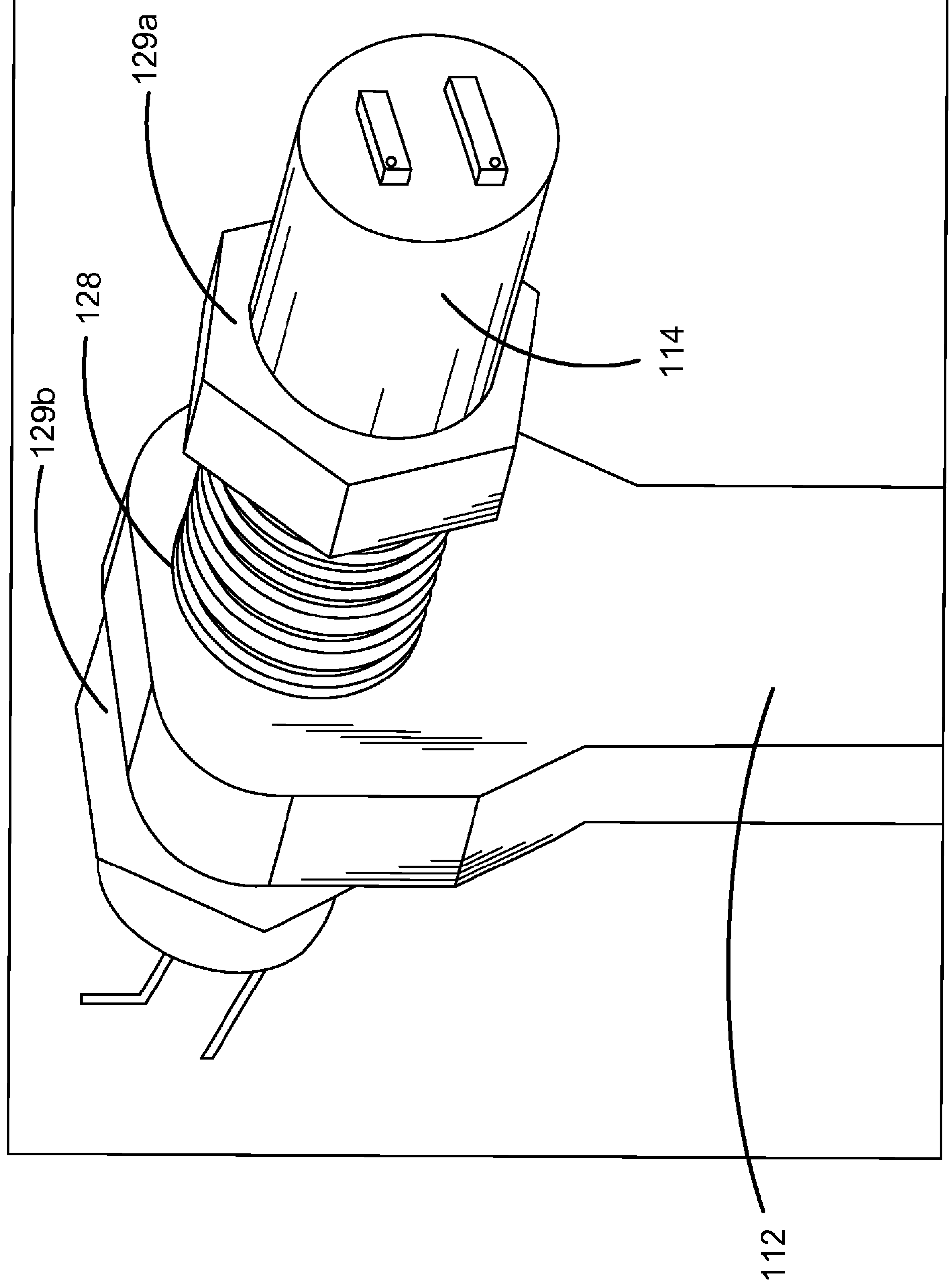

FIGURE 1B

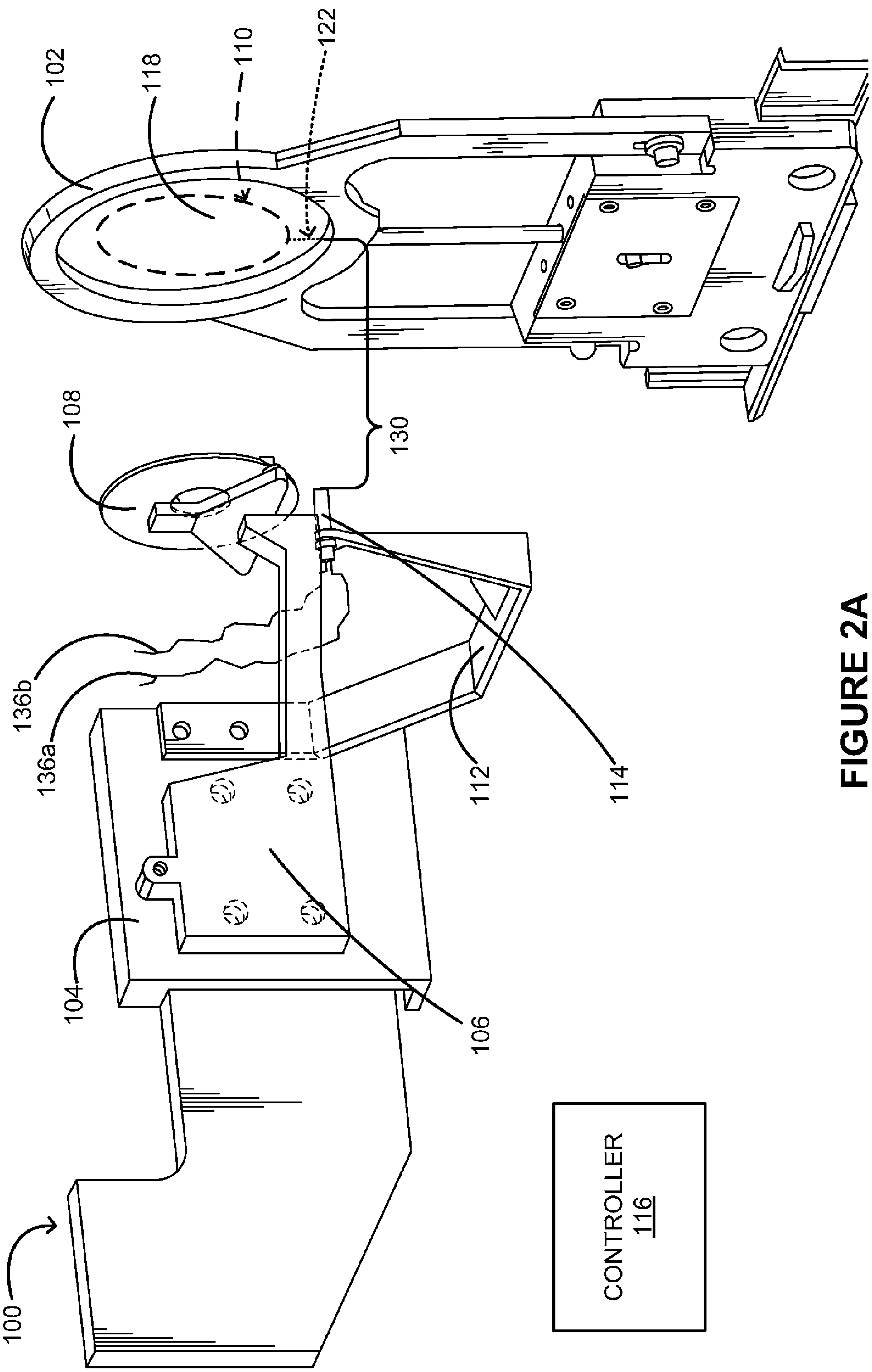
102
118
110
122
108
130
136b
136a
104
106
112
114
100
CONTROLLER
116

FIGURE 2A

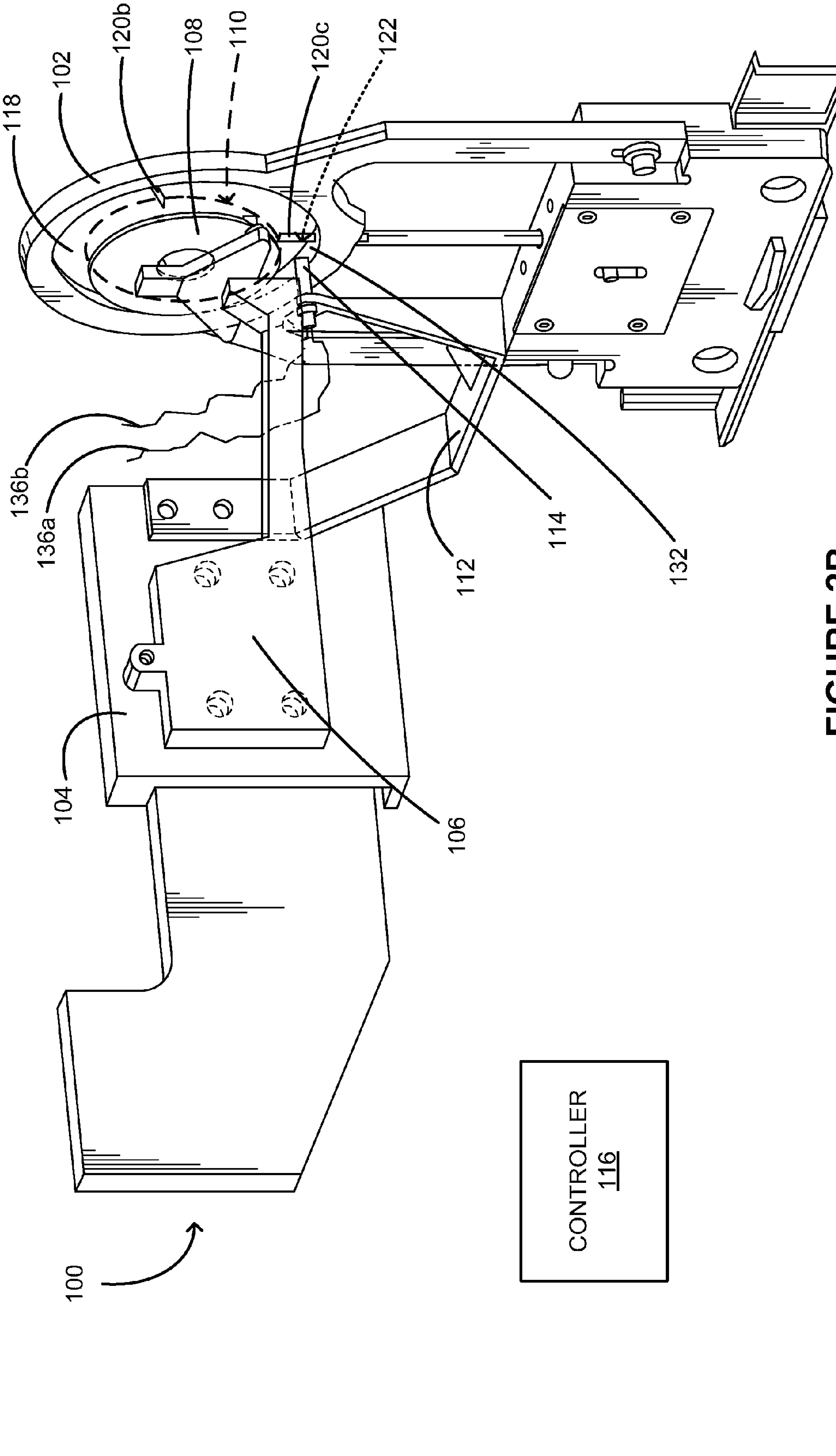
118
102
120b
108
110
120c
122
136b
136a
104
106
112
114
132
100
CONTROLLER
116

FIGURE 2B

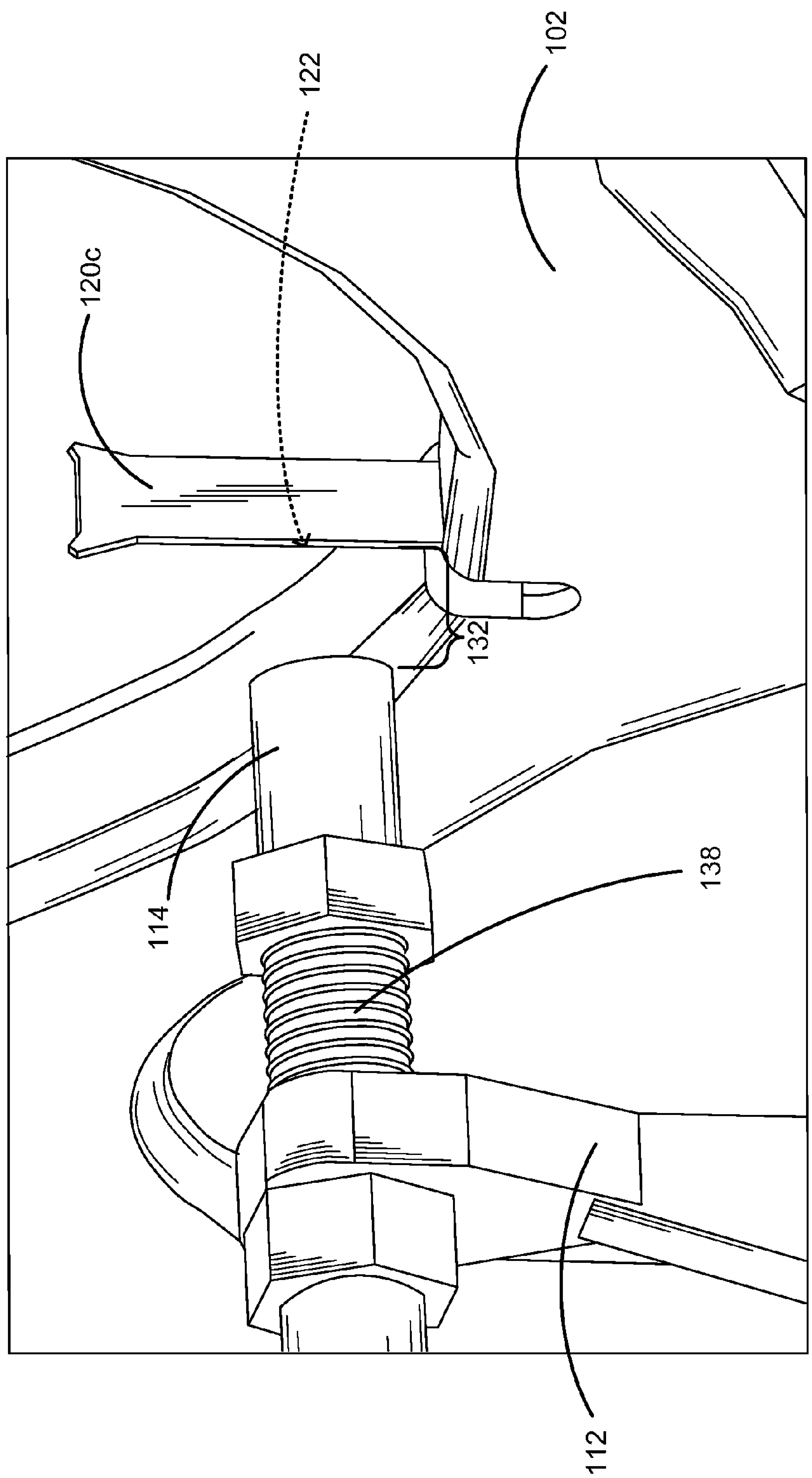

FIGURE 2C

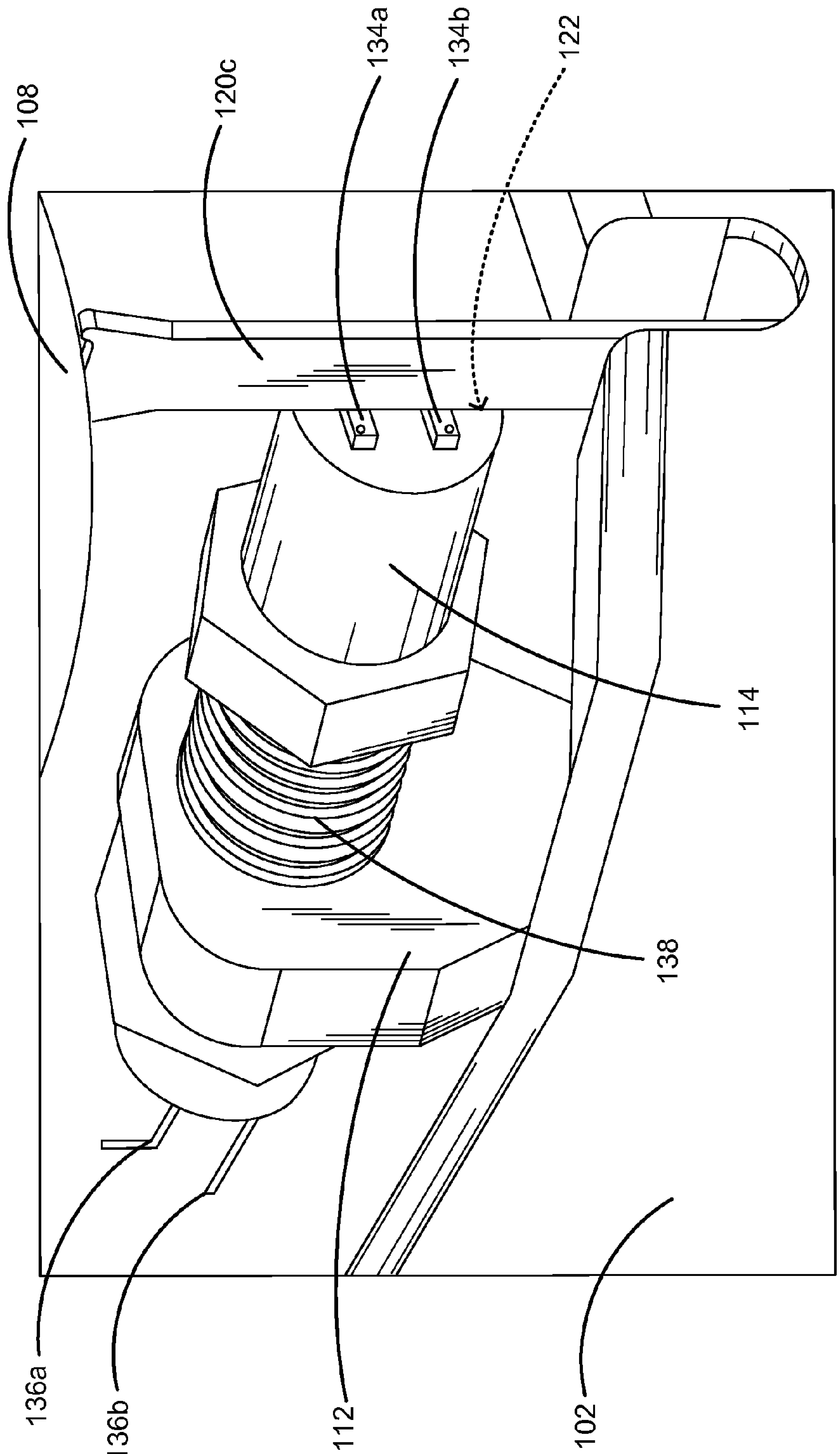

FIGURE 2D

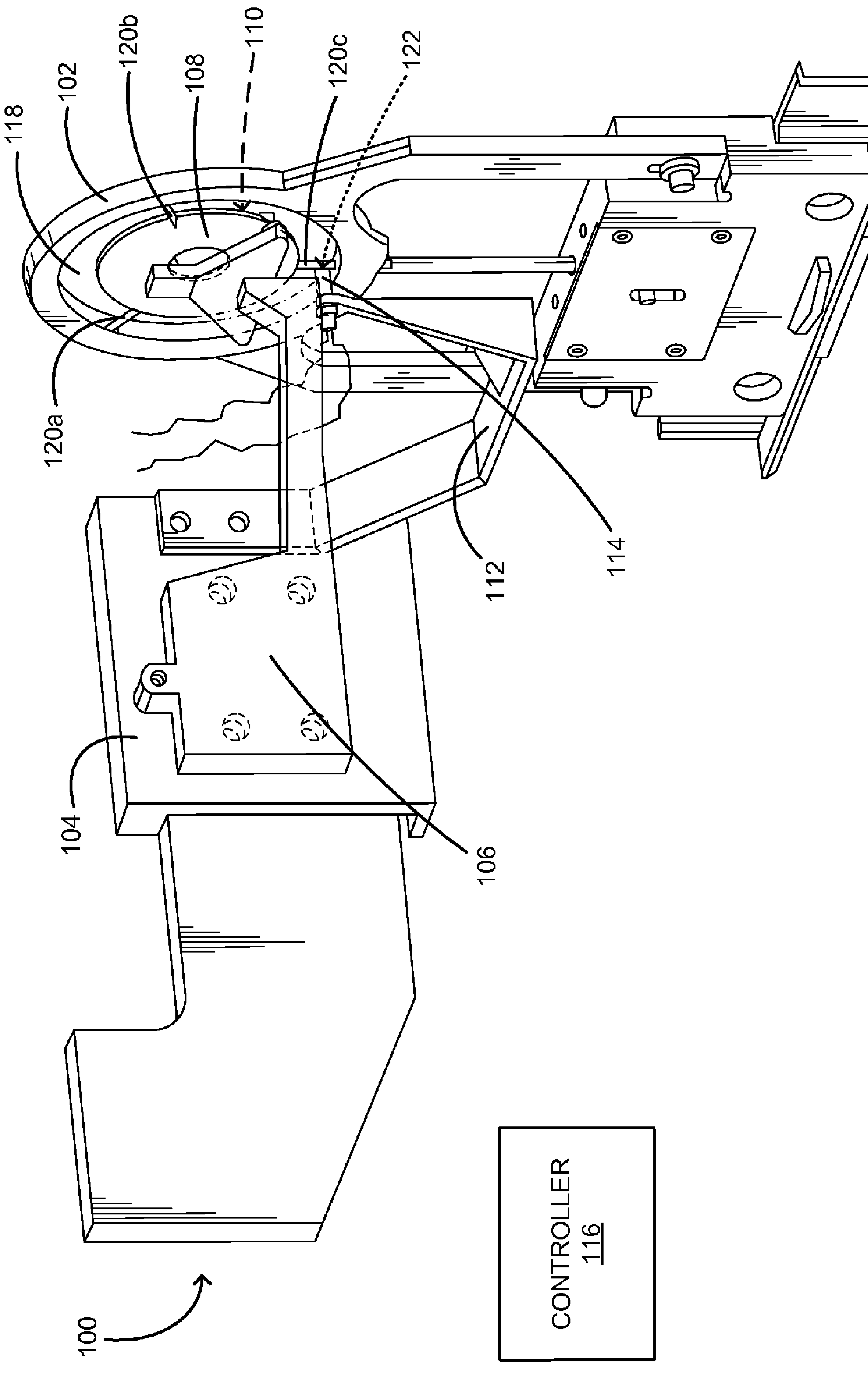
118
102
120b
108
110
120c
122
120a
114
112
104
106
100
CONTROLLER
116

FIGURE 2E

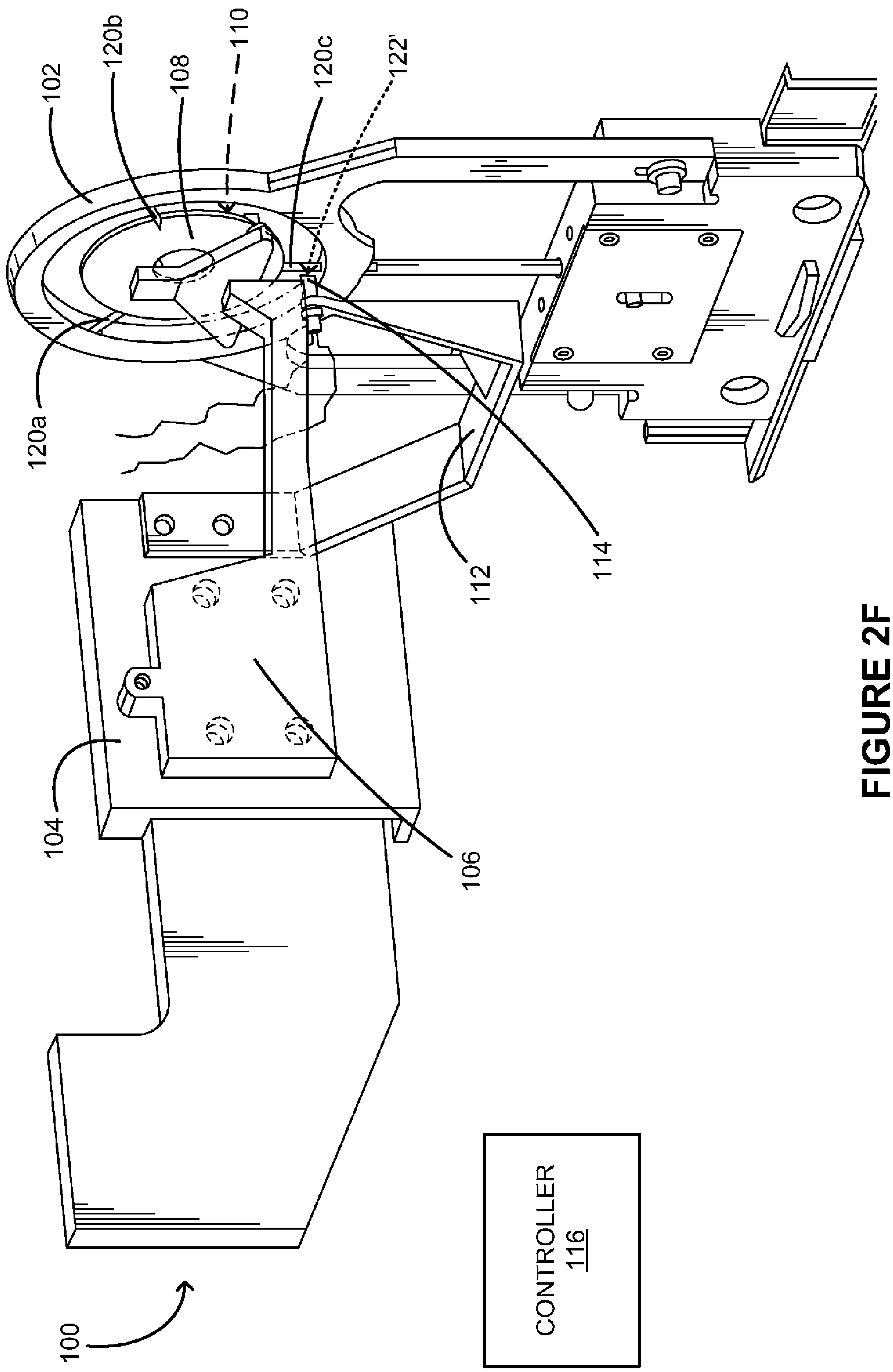
102
120b
108
110
120c
122'
120a
112
114
104
106
100
CONTROLLER
116

FIGURE 2F

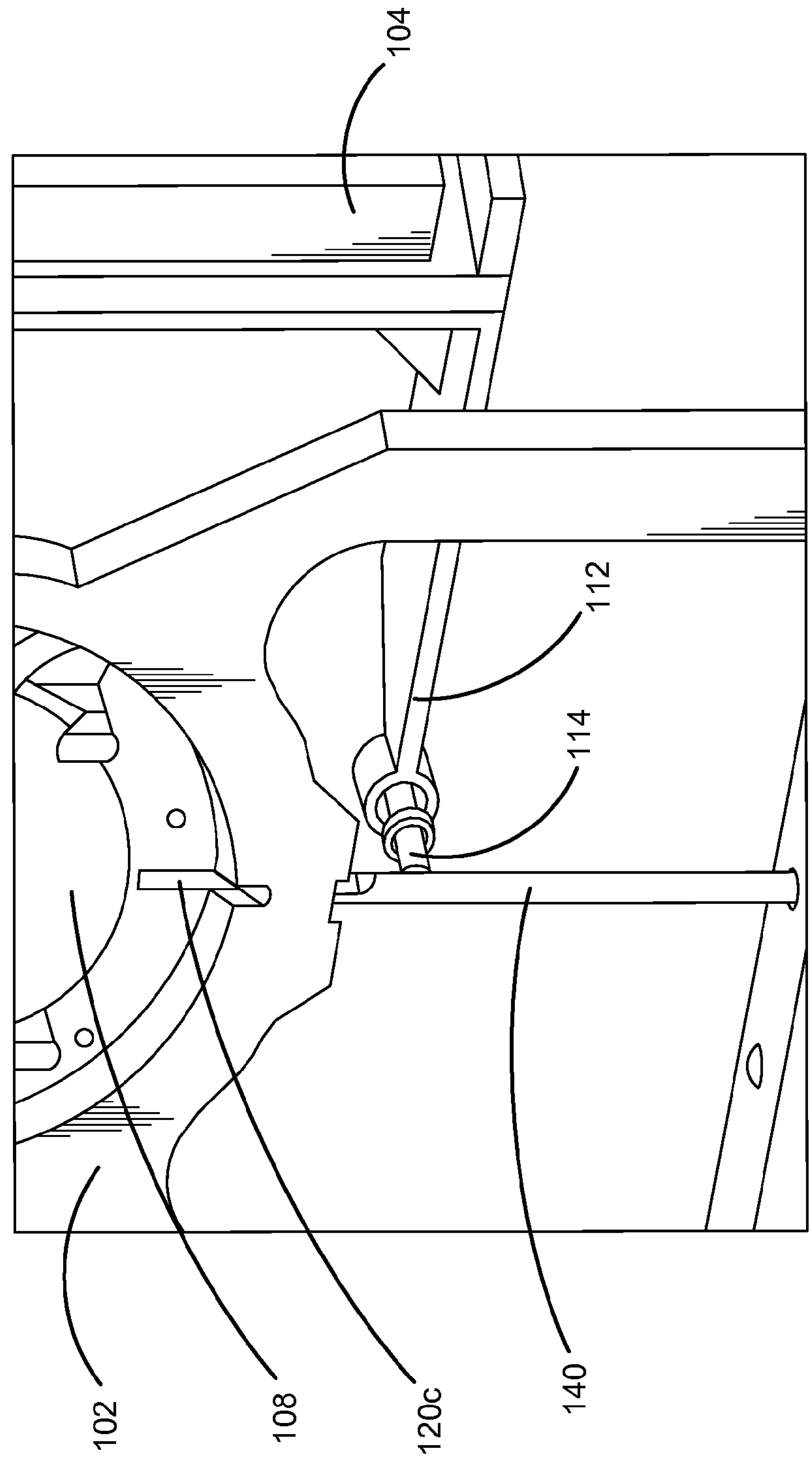

FIGURE 3

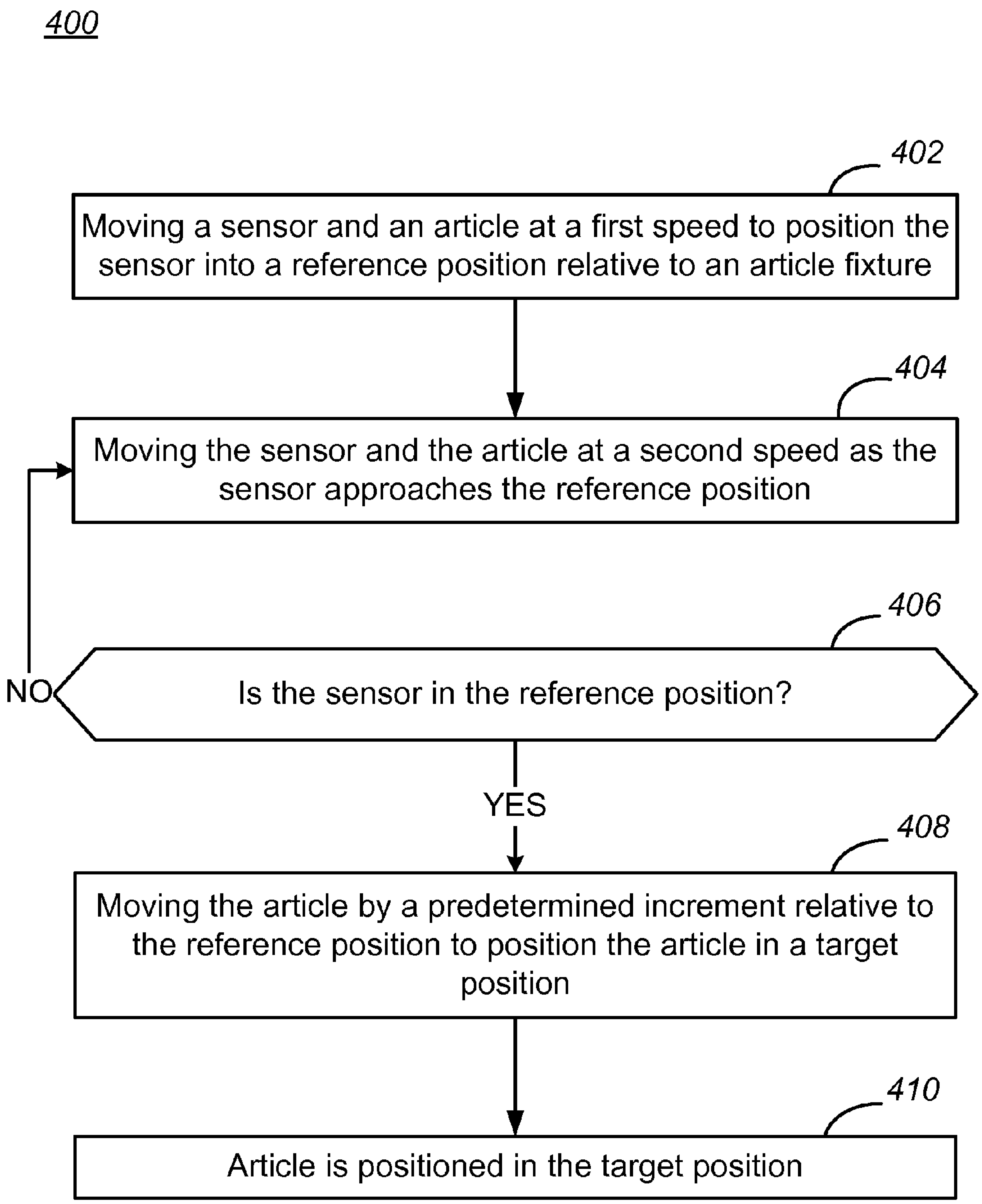
400
402
Moving a sensor and an article at a first speed to position the sensor into a reference position relative to an article fixture
404
Moving the sensor and the article at a second speed as the sensor approaches the reference position
406
Is the sensor in the reference position?
NO
YES
408
Moving the article by a predetermined increment relative to the reference position to position the article in a target position
410
Article is positioned in the target position

FIGURE 4

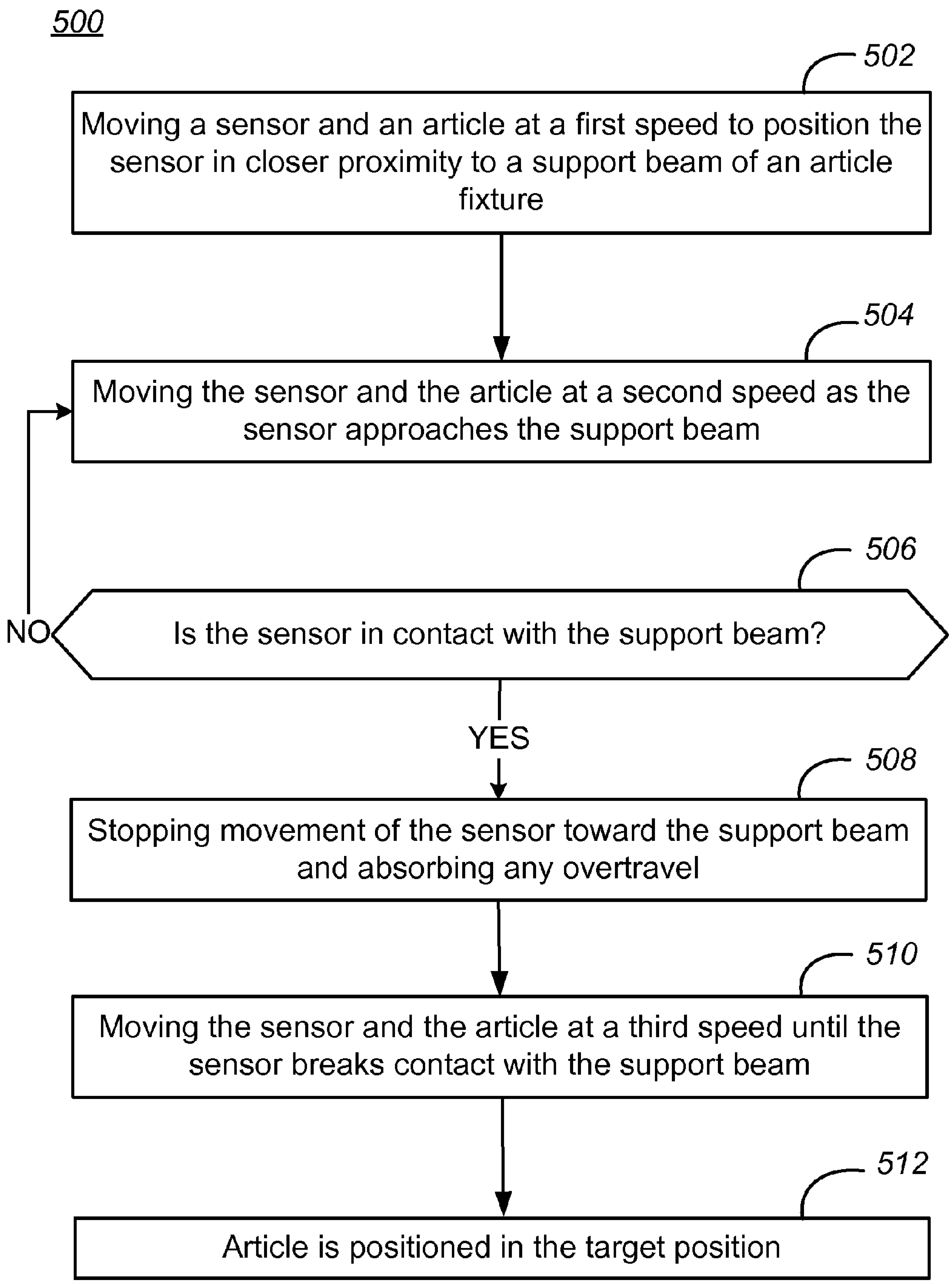
500
502
Moving a sensor and an article at a first speed to position the sensor in closer proximity to a support beam of an article fixture
504
Moving the sensor and the article at a second speed as the sensor approaches the support beam
506
Is the sensor in contact with the support beam?
NO
YES
508
Stopping movement of the sensor toward the support beam and absorbing any overtravel
510
Moving the sensor and the article at a third speed until the sensor breaks contact with the support beam
512
Article is positioned in the target position

FIGURE 5

POSITIONING APPARATUS

BACKGROUND

Generally, semiconductor substrates, such as hard disks, are manufactured by loading the substrates into different chambers of a substrate processing system. For instance, a semiconductor substrate may be loaded into a sputtering chamber, and subsequently loaded into an etching chamber, then loaded into a heating chamber, and then further loaded into a cooling chamber. To effectively process the surface of the substrate, it is appreciated that the substrate needs to be precisely positioned and located within the chamber.

SUMMARY

Provided herein is an apparatus including a loader configured to position a workpiece in a holding fixture. In some embodiments, the holding fixture includes an opening configured to removably receive the workpiece therein and hold the workpiece in a target position within the opening. The apparatus also includes position detecting means configured to translate a sensor to a predetermined location relative to the holding fixture and further configured to translate the workpiece by a predetermined increment relative to the predetermined location to position the workpiece in the target position.

These and other features and aspects of the concepts described herein may be better understood with reference to the following drawings, description, and appended claims.

DRAWINGS

FIGS. **1**A-**1**B show an apparatus for positioning an article in an article fixture according to one aspect of the present embodiments.

FIGS. **2**A-**2**F show sequential illustrations of an apparatus positioning an article in an article fixture according to aspects of the present embodiments.

FIG. **3** shows a portion of an apparatus for positioning an article in an article fixture according to one aspect of the present embodiments.

FIG. **4** shows an exemplary flow diagram for positioning an article according to one aspect of the present embodiments.

FIG. **5** shows an exemplary flow diagram for positioning an article according to one aspect of the present embodiments.

DESCRIPTION

Before various embodiments are described in greater detail, it should be understood by persons having ordinary skill in the art that the embodiments are not limiting, as elements in such embodiments may vary. It should likewise be understood that a particular embodiment described and/or illustrated herein has elements which may be readily separated from the particular embodiment and optionally combined with any of several other embodiments or substituted for elements in any of several other embodiments described herein.

It should also be understood by persons having ordinary skill in the art that the terminology used herein is for the purpose of describing the certain concepts, and the terminology is not intended to be limiting. Unless indicated otherwise, ordinal numbers (e.g., first, second, third, etc.) are used to distinguish or identify different elements or steps in

a group of elements or steps, and do not supply a serial or numerical limitation on the elements or steps of the embodiments thereof. For example, "first," "second," and "third" elements or steps need not necessarily appear in that order, and the embodiments thereof need not necessarily be limited to three elements or steps. It should also be understood that, unless indicated otherwise, any labels such as "left," "right," "front," "back," "top," "bottom," "forward," "reverse," "clockwise," "counter clockwise," "up," "down," or other similar terms such as "upper," "lower," "aft," "fore," "vertical," "horizontal," "proximal," "distal," and the like are used for convenience and are not intended to imply, for example, any particular fixed location, orientation, or direction. Instead, such labels are used to reflect, for example, relative location, orientation, or directions. It should also be understood that the singular forms of "a," "an," and "the" include plural references unless the context clearly dictates otherwise.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by persons of ordinary skill in the art to which the embodiments pertain.

Provided herein are embodiments to reliably load and position an article (e.g. disk, disc, substrate, etc.) in a target position within a commercially available article fixture. For example, the article fixture includes a clip to hold the article in a predetermined target position, such as the center of the article fixture. To load the article in this target position, the embodiments described herein further include a sensor to detect a reference position relative to the target position, such as an edge of the clip. In this example, when the sensor contacts the edge of the clip, it is determined that the sensor is in the reference position. In response, the article is moved by a predetermined increment relative to the edge of the clip to accurately position the article in the desired target position (e.g., position the article in the center of the article fixture). By establishing contact between the sensor and the clip at the reference position, false positive indications while loading the article are substantially reduced and/or effectively eliminated. Consequently, by affirmatively identifying the location and the position of the edge of the clip, the embodiments described herein accurately load and position the article. In this way, articles are consistently, repeatably and precisely positioned in the predetermined and desired target position.

Referring now to FIG. **1**A, an apparatus for positioning an article in an article fixture is shown according to one aspect of the present embodiments. Apparatus **100** includes, but is not limited to, an article fixture **102**, a loader **104**, an article loading arm **106** attached to the loader **104** for loading and positioning an article **108** in a target position **110** (also see FIG. **2**A for clarity), a sensor arm **112**, a sensor **114**, and a controller **116**.

Before proceeding to further describe the various components of the apparatus **100**, it is appreciated that the article **108** as described herein may be, but is not limited to, semiconductor wafers, magnetic recording media (e.g., hard disks for hard disk drives), and workpieces thereof in any stage of manufacture.

Referring now to the article fixture **102**, in some embodiments, the article fixture **102** may be a fixture to hold an article through one or more processing steps, such as sputtering, etching, heating, cooling, etc. The article fixture **102** includes an opening **118** that removably receives the article **108** therein and holds the article **108** in the target position **110**. As illustrated in FIG. **1**A, the article **108** is positioned in the target position **110**. The article fixture **102** further includes clips **120***a*, **120***b* and **120***c*, which are configured to support and secure the article **108** in the target position **110** while the article **108** is being processed.

As described in greater detail below, the apparatus **100** provides a position detecting means for reliably, repeatably, and precisely positioning the article **108** in the target position **110**. In FIG. **1**A, the loader **104** is operably coupled to the article loading arm **106** that holds the article **108**, and is operably coupled to the sensor arm **112**, which holds the sensor **114**. The loader **104** is configured to move the article loading arm **106** and the sensor arm **112** in a path toward and/or away from the article fixture **102** to position the article **108** and the sensor **114** in the target position **110** and a reference position **122** (also see FIG. **2**A for clarity), respectively. It is noted that references will be made throughout the detailed description of the article loading arm **106** and the sensor arm **112** moving, for instance, the article **108** and the sensor **114**; however, it is appreciated that in this embodiment one non-limiting example is presented wherein the movement of the article loading arm **106** and the sensor arm **108** is caused by the movement of the loader **104**.

As noted above, the loader **104** is operably coupled to the article loading arm **106** that holds the article **108** while being translated toward the article fixture **102** to load the article **108** into the target position **110**. The article loading arm **106** includes an article support **124** that includes multiple hooks **126***a* and **126***b* to secure the article **108** when loaded thereon. The article loading arm **106** supports the article **108** in a vertical planar position to load the article **108** in the article fixture **102**. In some embodiments, the article loading arm **106** holds the article **108** in a horizontal planar position, a diagonal position, and/or some other user/system defined position.

As noted above, the loader **104** is also operably coupled to the sensor arm **112**. Sensor arm **112** includes the sensor **114**, the body of which is secured and positioned within a through hole **128** of the sensor arm **112**, as illustrated in FIG. **1**B. In FIG. **1**B, the sensor **114** further includes fasteners (e.g. nuts **129***a* and **129***b*) to keep the sensor **114** in place while the sensor arm **112** translates toward and away from the article fixture **102**. Various embodiments may include any fastener (e.g. bolt, screw, weld, glue, adhesive, etc.) operable to secure the sensor **144** in a predetermined position while the sensor arm **112** translates.

Returning to FIG. **1**A, in some instances, the sensor arm **112** translates the sensor **114** toward the article fixture **102** until the sensor **114** is in the reference position **122**. The sensor **114** is determined to be in the reference position **122** when the sensor **114** establishes contact with a selected portion of the article fixture **102**, such as a near edge of the clip **120***c* as illustrated in FIG. **1**A. In some instances, the sensor **114** is determined to be in the reference position **122** when the sensor **114** closes an electrical circuit, which is described in greater detail in connection with FIGS. **2**A-**2**F.

Once it is determined that the sensor **114** is in the reference position **122**, it is appreciated that the position of the article **108** may need to be further adjusted to position the article **108** in the target position **110**. In some instances, the sensor arm **112** moves the article **108** toward the target position **110** by a predetermined increment relative to the reference position **122**, which is described in greater detail in connection with FIGS. **2**A-**2**F. It is appreciated that once the sensor **114** is in the reference position **122**, the reference position **122** provides a known positional/locational relationship with the target position **110** that allows the apparatus **100** to repeatably and precisely locate and load the article **108** in the target position **110**.

The apparatus **100** further includes the controller **116**. In some embodiments, the controller **116** is communicatively coupled (not shown) to the loader **104** to cause the loader **104** to translate in a path toward and/or away from the article fixture **102**. In some instances, the controller **116** includes a motion control system, such as a stepper motor, electric motor, linear actuator, hydraulic pump, and so forth, that causes the loader **104** to automatically translate by certain distances or by specific, predetermined, and/or calculated increments. It is appreciated that when the controller **116** causes the loader **104** to move, the controller **116** further causes the movement of the article loading arm **106** along with the article **108**, the sensor arm **112**, and the sensor **114**.

In some embodiments, the controller **116** includes a computer, such as a desktop computer, a workstation, a portable device (e.g., a mobile device, a tablet, a laptop, or a smartphone), or some computing device configured to automatically cause an article to be positioned in a target position. In some instances, the controller **116** is programmed and/or reprogrammed by a user/system that defines the reference position, the target position, and/or the predetermined increments to adjust the article into the target position. By being able to program the controller **116** for various features, it is appreciated that the apparatus **100** provides the convenience and flexibility to adjust the apparatus **100** without much downtown and/or manual adjustments.

Referring now to FIGS. **2**A-**2**F, sequential illustrations of an apparatus positioning an article in an article fixture is shown according to aspects of the present embodiments. For clarity of illustration, clips **120***a*, **120***b*, and **120***c* are not illustrated in FIG. **2**A, however the clips are illustrated in FIGS. **2**B-**2**F. Specifically, FIGS. **2**A-**2**F show sequential illustrations of positioning an article, such as the article **108**, by translating the sensor **114** until contact is established between the sensor **114** and a near edge of the clip **120***c* (e.g., the reference position **122** illustrated with dashed lines), and then, if appropriate, further positioning the article **108** in a vertical planar position in the center of the opening **118** of the article fixture **102** (e.g., the target position **110** illustrated with dashed lines).

FIG. **2**A shows the apparatus **100** positioned in an initial position to load the article **108** in the article fixture **102**. Specifically, in FIG. **2**A, the article **108** is supported by the article loading arm **106** in a vertical planar position facing the opening **118** and the sensor **114** positioned in an initial position, which is a position located at a predetermined distance **130** away from the reference position **122**. In order to efficiently locate the reference position **122** and ultimately position the article **108** in the target position **110**, the controller **116** then causes the sensor arm **112** to quickly translate the sensor **114** from the initial location as illustrated in FIG. **2**A to a location in closer proximity to the reference position **122**, e.g., near the edge of the clip **120***c*, as shown in FIG. **2**B. Once the sensor **114** is at a location at or past the location of closer proximity to the reference position **122**, the controller **116** then slows down the movement of the sensor **114** until the sensor **114** is in the reference position **122**, as shown in FIG. **2**E.

More particularly, in this example, the sensor arm **112** moves the sensor **114** from the initial position as illustrated in FIG. **2**A at a first speed to quickly translate the sensor **114** to a location that is closer than the initial position to the edge of the clip **120***c*, such as distance **132** as illustrated in FIGS. **2**B and **2**C. Once the sensor **114** is at the distance **132** or less from the clip **120***c*, the sensor arm **112** moves the sensor **114** at a slower speed until the sensor **114** establishes contact with the edge of the clip **120***c*. By slowing the movement speed of the sensor **114**, the movement of the sensor **114** and the sensor arm **112** may quickly come to a stop when contact is established between the sensor **114** and the near edge of clip **120***c*.

It is appreciated that by initially moving the sensor **114** at a faster speed and then moving the sensor **114** at a slower speed, certain efficiencies may be achieved. Because the reference position **122** (e.g., the near edge of the clip **120***c*) is a known position relative to the sensor's **114** initial position as illustrated in FIG. **2**A, the sensor **114** is initially moved at a faster speed to proximately position the sensor **114** near the actual reference position **122**, which allows the sensor **114** to be accurately positioned in the reference position **122** in a shorter amount of time than if a single positioning speed (whether faster or slower) were employed. More specifically, a slower speed takes longer to reach the reference position **122**; a faster speed makes undershooting or overshooting the reference position **122** more likely. Therefore, by utilizing the dual speed approach as taught herein, an article may be efficiently and accurately loaded into a target position in a minimal amount of time.

As noted above, the sensor arm **112** continues to translate the sensor **114** toward the article fixture **102** until the sensor **114** is in the reference position **122**. In other words, the sensor arm **112** moves the sensor **114** until the sensor **114** establishes contact with the near edge of the clip **120***c*. Here, contact is determined to be established when a surface of the sensor **114** and the edge of the clip **120***c* closes an electrical circuit, which is described in greater detail below in connection with FIG. **2**D.

In FIG. **2**D, the sensor **114** includes electrical contacts **134***a* and **134***b* and electrical transmission conductors **136***a* and **136***b* coupled to the controller **116** (not shown). In some instances, the electrical contacts **134***a* and **134***b* may be of an electrically conductive material, such as silver, gold, copper, stainless steel, titanium, platinum, Inconel, and so forth. In some instances, the electrical contacts **134***a* and **134***b* may be of a material that is electrically conductive and a material that leaves little to no residue upon contact with the clip **120***c*, to prevent contamination of the article **108** during processing. Further, in some instances, the surface of the clip **120***c* may be of an electrically conductive material other than a metal. For example, the surface of the clip **120***c* may be coated with a diamond-like carbon (DLC) coating.

In such an arrangement, the controller **116** supplies a certain amount of voltage, such as 24 volts (V), to the sensor **114** via the electrical transmission conductors **136***a* and **136***b*. As such, when the electrical contacts **134***a* and **134***b* contact the near edge of the clip **120***c*, a complete electrical circuit is formed back to the controller **116**. When the controller **116** receives the contact-confirming electrical signal, then it is determined that the sensor **114** is in the reference position **122**, and no longer needs to be continued to be moved toward the reference position **122**.

However, it is appreciated that, in some instances, the sensor arm **112** may nominally overtravel during movement of the sensor **114** into the reference position **122**. That is, the momentum of the loader **104**, after the loader **104** is told by the controller **116** to stop, may cause the loader **104** and the sensor arm **112** to continue to move a nominal distance after the sensor **114** has established contact with the near edge of the clip **120**. In such a scenario, if the sensor arm **112** continues to move after the sensor **114** is in contact with the clip **120***c*, the sensor arm **112** and the sensor **114** may apply strain and pressure on the clip **120***c* and possibly damage the clip **120***c*.

Accordingly, to prevent damage to the clip **120***c*, the sensor **114** includes a means for absorbing an overtravel by the sensor arm **112** as the sensor **114** is moved into the reference position **122**. In some instances, the means for absorbing may include a spring, such as spring **138** as shown in FIGS. **2**C and **2**D, that permits the sensor **114** to retract relative to the sensor arm **112** whenever the sensor arm **112** overtravels during movement into the reference position **122**. In some instances, the spring **138** may be a steel spring. In some embodiments, the means for absorbing may include a shock suspension pump, a dashpot, or some other device that may be used to absorb an overtravel by the sensor arm **112**. In this way, the means for absorbing provides a mechanism for contact-based positioning while preventing damage to the article fixture **102**.

Once contact is established between the sensor **114** and the near edge of the clip **120***c*, the sensor **114** is in the reference position **122** as illustrated in FIG. **2**E. It is appreciated that after the sensor **114** is moved into the reference position **122**, the article **108** may not be in the target position **110**. As such, in some embodiments, the article **108** is moved by a predetermined increment relative to the reference position **122** to position the article **108** into the target position **110**. For instance, the predetermined increment may be based on the relative distance between the reference position **122** and the target position **110**. For example, if it is known that the target position **110** is a distance X away from the reference position **122**, then the loader **104** translates the article **108** by predetermined increments based on distance X. For instance, the loader **104** may translate the article **108** by 2 increments of 0.5X, or by 1 increment of X, etc., toward the target position **110**.

In some instances, the reference position may be coincident with the target position, and as such, the predetermined increment may be null. In other words, the article **108** is placed into the target position **110** simultaneously as the sensor **114** is placed into the reference position **122**. This is in contrast with other instances in which the reference position may not be coincident with the target position, and the predetermined increment will be greater than null.

In some alternative embodiments, the article **108** is moved toward the target position **110** by breaking contact between the sensor **114** and the near edge of the clip **120***c* after contact has first been made, as illustrated in FIG. **2**F. In such a scenario, the controller **116** causes the loader **104** to move the sensor **114** in reverse by a predetermined increment after the circuit formed by the sensor **114** and the clip **120***c* opens. In some instances, the predetermined increment may include a number of subsequential incremental movements to break contact between the sensor **114** and the clip **120***c*. In this instance, as the contact is broken, the loader **104** then moves the article **108** into the target position **110**. For example, if three increments of a stepper motor step are used to break contact between the sensor **114** and the clip **120***c*, then the sensor **114** and the article **108** are moved by three increments relative to the reference position **122'** to place the article in the target position **110**. Once the circuit opens and the return signal voltage is removed from the controller **116**, it is determined that the contact between the sensor **114** and the clip **120***c* has been broken, and thus, article **108** can be accurately positioned in the target position **110**.

After the article **108** is positioned in the target position **110**, the article loading arm **106** releases the article **108**. Then, the loader **104** retracts the sensor arm **112** along with the sensor **114** and the article loading arm **106** away from the article fixture **102**, and then the article **108** is processed within the article fixture **102**.

Although FIG. **1**A and FIGS. **2**A-**2**F illustrate the article fixture **102** with a circular opening, it is intended to be exemplary and is not intended to limit the scope of the embodiments. In some embodiments, the opening may be a square or rectangular shaped opening. In some embodiments, the shape of the opening may be dependent on the type of article being processed. It is further appreciated that the illustration in FIG. **1**A and FIGS. **2**B-**2**F of three clips (e.g., clips **120***a*, **120***b* and **120***c*) is illustrative and is not intended to limit the scope of the embodiments described herein. In some embodiments, the article fixture described herein may have fewer than or more than three clips. In some embodiments, the article fixture **102** may have no clips, and an article may be supported by a rim of the article fixture instead. In some embodiments, the article fixture **102** may include a cradle that supports an article within the opening, rather than clips.

Further, it is appreciated that the illustration in FIG. **1**A and FIGS. **2**A-**2**F of the target position as a centered vertical planar position within the article fixture is intended to be exemplary and is not intended to limit the scope of the embodiments. It is appreciated that in some embodiments, the target position may be an off-centered vertical planar position, a centered horizontal position, and/or a user/system defined position that is optimal for processing the article during sputtering, etching, etc.

In FIG. **1**A and FIGS. **2**A-**2**F, the discussion of the reference position with respect to the near edge of clip **120***c* is intended to be exemplary and is not intended to limit the scope of the embodiments. In some embodiments, the clip **120***a*, the clip **120***b* and/or all the clips **120***a*, **120***b* and **120***c* may be used as a reference position to position an article into a target position. In some embodiments, for example, the reference position may be a support beam, such as support beam **140** as shown in FIG. **3**. In one example, the reference position may be on a location on the rim of the opening **118**. In some instances, the reference position may be anywhere on or a known position relative to the article fixture **102**, whether the reference position is near thereto or remotely located with reference to the apparatus **100**. It is appreciated that the reference position may be a user/system defined position that provides a frame of reference to predictably locate and position an article in a target position.

FIG. **4** shows an exemplary flow diagram for positioning an article according to one aspect of the present embodiments. At block **402**, a sensor and an article are moved at a first speed to position the sensor into a reference position relative to an article fixture. In some embodiments, the sensor and article may be substantially similar to the sensor **114** and the article **108**. In some embodiments, the sensor and the article may be moved by a predetermined distance from an initial position to position the sensor in a location in closer proximity to a reference position, such as an edge of a clip as described herein. In some embodiments, the sensor and article may be moved in a substantially similar manner as described in FIGS. **2**A-**2**F. In some embodiments, the first speed may be some user/system defined speed that allows the sensor to be in a location in closer proximity to the reference position in a short period of time.

At block **404**, the sensor and the article are moved at a second speed as the sensor approaches the reference position. For instance, the sensor and the article may be moved at a second speed that is slower in comparison to the first speed in block **402** as the sensor comes into closer proximity to the reference position. In some embodiments, the sensor and the article are moved in a substantially similar manner, as described in FIGS. **2**A-**2**F.

At block **406**, it is determined whether the sensor is in the reference position. In some embodiments, the sensor is determined to be in the reference position when contact is established between the sensor and a portion of an article fixture, such as an edge of a clip and/or a support beam of the article fixture. In some embodiments, the sensor is determined to be in the reference position when the sensor closes a circuit when in contact with an electrically conductive portion of the article fixture and/or when in contact to an electrically conductive surface located in a relatively known position with respect to the article fixture and/or the target position. In some embodiments, the determination is performed in a substantially similar manner as described in FIG. **1**A and FIGS. **2**A-**2**F.

In some embodiments, if it is determined that the sensor is not in the reference position, then method **400** returns to block **404** to continue to move the sensor and the article at the second speed as the sensor approaches the reference position. Otherwise, method **400** proceeds to block **408**.

At block **408**, the article is moved by a predetermined increment relative to the reference position to position the article in a target position. In some embodiments, the article may be moved by a loader, such as loader **104**, by the predetermined increment to position the article in the target position. In some embodiments, the article is moved by a predetermined increment in a substantially similar manner as described in FIG. **1**A and FIGS. **2**A-**2**F. Once the article is moved by the predetermined increment, then the article is positioned in the target position (block **410**).

FIG. **5** shows an exemplary flow diagram for positioning an article according to one aspect of the present embodiments. At block **502**, a sensor and an article are moved at a first speed to position the sensor in closer proximity to a support beam of an article fixture. In some embodiments, the sensor and the article may be moved by a predetermined increment from an initial position, such as the initial position described in FIG. **2**A, to position the sensor in a location in closer proximity to the support beam, such as support beam **140**. As noted in block **402** of FIG. **4**, the first speed may be some user/system defined speed that allows the sensor to be in a location in closer proximity to the support beam in a short period of time.

At block **504**, the sensor and the article are moved at a second speed as the sensor approaches the support beam. Similar to block **404** of FIG. **4**, the sensor and the article may be moved at a second speed that is slower in comparison to the first speed in block **502** as the sensor comes into closer proximity to the support beam.

At block **506**, it is determined whether the sensor is in contact with the support beam (i.e., in the reference position). In some embodiments as described herein, the sensor is determined to be in contact with the support beam when the sensor forms a closed circuit with the support beam. For instance, when a controller as described herein receives a contact-confirming electrical signal, then it is determined that the sensor is contact with the support beam.

In some embodiments, if it is determined that the sensor is not in contact with the support beam, the method **500** returns to block **504** to continue to move the sensor and the article at the second speed. Otherwise, method **500** proceeds to block **508** to stop the movement of the sensor toward the support beam. For instance, a controller as described herein may signal a loader and/or a sensor arm to stop the movement of the sensor. However, it is appreciated that a sensor arm and/or loader as described herein may nominally overtravel after the sensor is in contact with the support beam. As such, if there is any overtravel, the overtravel is absorbed. In some instances, the sensor includes a means for absorbing an overtravel, such as spring **138**.

At block **510**, the sensor and the article are moved at a third speed until the sensor breaks contact with the support beam. In some embodiments, the sensor and the article are moved by a predetermined increment in a similar manner as described in FIGS. **2**E-**2**F. In some embodiments, it is determined that contact between the sensor and the support beam is broken when the circuit formed by the sensor and the support beam opens. In some embodiments, the third speed may be a slower speed in comparison to the first speed and the second speed of blocks **502** and **504**, respectively. It is appreciated that by slowing the movement of the sensor and the article, the article may be positioned in the target position without undershooting or overshooting the target position. Once contact between the sensor and the support beam is broken, then the article is positioned in the target position (block **512**).

As such, provided herein is an apparatus including an article fixture configured to hold an article in a predetermined target position, a loader configured to position the article in the target position, and a sensor arm including a sensor and operably connected to be moved by the loader as the loader positions the article. In some embodiments, the loader is configured to move the sensor into a reference position, and to move the sensor by a predetermined increment relative to the reference position to cause the loader to position the article in the target position.

In some embodiments, the reference position is coincident with the target position; and the predetermined increment is null. In some embodiments, the sensor is configured to be in the reference position when contact is established between the sensor and a surface of the article fixture. In some embodiments, the sensor arm is configured to move the sensor by the predetermined increment relative to contact between the sensor and the surface of the article fixture.

In some embodiments, the sensor arm is configured to move the sensor by a first predetermined distance at a first speed from an initial location to a location in closer proximity to the reference position, and the sensor arm is further configured to move the sensor to the reference position at a second speed when the sensor is at or past the location in closer proximity to the reference position. In some embodiments, the first speed is faster in comparison to the second speed.

In some embodiments, the sensor includes electrical contacts configured to contact a surface of the article fixture when the sensor is in the reference position, the surface of the article fixture that is in contact is electrically conductive, and the contact between the sensor and the electrically conductive article fixture surface closes an electrical circuit.

In some embodiments, the apparatus further includes means for absorbing an overtravel by the sensor arm as the sensor is moved into the reference position. The means for absorbing further includes a spring for the sensor that is configured to permit the sensor to retract relative to the sensor arm whenever the sensor arm overtravels during movement into the reference position, in some embodiments.

Also provided herein is an apparatus including a loader configured to position a workpiece in a holding fixture. In some embodiments, the holding fixture includes an opening configured to removably receive the workpiece therein and hold the workpiece in a target position within the opening. The apparatus also includes position detecting means configured to translate a sensor to a predetermined location relative to the holding fixture and further configured to translate the workpiece by a predetermined increment relative to the predetermined location to position the workpiece in the target position.

In some embodiments, the position detecting means includes a workpiece loader configured to load the workpiece in the holding fixture in the target position. The position detecting means further includes a sensor arm that includes the sensor and operably connected to be moved by the loader, and configured to translate the sensor to the predetermined location and further configured to move the sensor by the predetermined increment to cause the workpiece loader to load the workpiece in the target position, in some embodiments. In some embodiments, the holding fixture includes a clip configured to support the workpiece in the target position, and the sensor is translated to the predetermined location when the sensor is in contact with a portion of the clip. In some embodiments, the predetermined location is coincident with the target position, and the predetermined increment is null.

In some embodiments, the position detecting means is further configured to translate the sensor by a first predetermined distance at a first speed from an initial location to a location in closer proximity to the predetermined location, and translate the sensor to the predetermined location at a second speed when the sensor is at or past the location in closer proximity to the predetermined location. In some embodiments, the first speed is faster in comparison to the second speed.

Also provided herein is a method including moving a sensor and an article at a first speed to position the sensor into a reference position relative to an article fixture, moving the sensor and the article at a second speed as the sensor approaches the reference position, determining when the sensor is in the reference position, and moving the article by a predetermined increment relative to the reference position to position the article in a target position in response to determining that the sensor is in the reference position.

In some embodiments, moving at the first speed is faster in comparison to moving at the second speed. In some embodiments, determining when the sensor is in the reference position includes determining when a portion of the sensor comes into contact with a portion of the article fixture.

In some embodiments, the method further includes moving the sensor by the predetermined increment in response to determining that the sensor is in the reference position. In some embodiments, positioning the sensor in the reference position includes establishing contact between the sensor and a portion of the article fixture, and moving the sensor by the predetermined increment includes removing contact between the sensor and the article fixture.

While the embodiments have been described and/or illustrated by means of particular examples, and while these embodiments and/or examples have been described in considerable detail, it is not the intention of the Applicants to restrict or in any way limit the scope of the embodiments to such detail. Additional adaptations and/or modifications of the embodiments may readily appear to persons having ordinary skill in the art to which the embodiments pertain, and, in its broader aspects, the embodiments may encompass these adaptations and/or modifications. Accordingly, departures may be made from the foregoing embodiments and/or examples without departing from the scope of the concepts described herein. The implementations described above and other implementations are within the scope of the following claims.

What is claimed is:

1. An apparatus comprising:

a fixture configured to hold a recording media in a predetermined target position;

a loader configured to position the recording media in the target position in the fixture; and

a sensor arm including a sensor and operably connected to be moved by the loader as the loader positions the recording media in the fixture,

the loader being configured:

to move the sensor into a reference position, with respect to a portion of the fixture, wherein the sensor detects the reference position while holding the recording media, and wherein further the sensor is configured to be in the reference position when a contact is established between the sensor and a surface of the fixture, and

to move the sensor by a predetermined increment relative to the reference position to cause the loader to position the recording media in the target position in the fixture.

2. The apparatus of claim 1, wherein

the reference position is coincident with the target position; and

the predetermined increment is null.

3. The apparatus of claim 1, wherein the sensor arm is configured to move the sensor by the predetermined increment relative to the contact between the sensor and the surface of the fixture.

4. The apparatus of claim 1, wherein

the sensor arm is configured to move the sensor by a first predetermined distance at a first speed from an initial location to a location in closer proximity to the reference position; and

the sensor arm is further configured to move the sensor to the reference position at a second speed when the sensor is at or past the location in closer proximity to the reference position.

5. The apparatus of claim 4, wherein the first speed is faster in comparison to the second speed.

6. The apparatus of claim 1, wherein

the sensor includes electrical contacts configured to contact the surface of the fixture when the sensor is in the reference position;

the surface of the fixture that is in contact is electrically conductive; and

the contact between the sensor and the electrically conductive fixture surface closes an electrical circuit.

7. The apparatus of claim 1 further comprising:

means for absorbing an overtravel by the sensor arm as the sensor is moved into the reference position.

8. The apparatus of claim 7, wherein the means for absorbing further comprises a spring for the sensor that is configured to permit the sensor to retract relative to the sensor arm whenever the sensor arm overtravels during movement into the reference position.

9. An apparatus comprising:

a loader configured to position a workpiece in a holding fixture, the holding fixture including an opening configured to removably receive the workpiece therein and hold the workpiece in a target position within the opening; and

a sensor, wherein

the sensor is positioned to establish contact with the holding fixture, and

the loader is configured to translate the sensor to a predetermined location relative to the holding fixture, wherein the sensor establishes a contact with the holding fixture at the predetermined location, and the loader is further configured to translate the workpiece by a predetermined increment relative to the predetermined location to position the workpiece in the target position, wherein the sensor maintains the contact with the holding fixture during translation of the workpiece to the target position.

10. The apparatus of claim 9, further comprising

a sensor arm that includes the sensor and operably connected to be moved by the loader, and configured to translate the sensor to the predetermined location and further configured to move the sensor by the predetermined increment to cause the workpiece loader to load the workpiece in the target position.

11. The apparatus of claim 9, wherein

the holding fixture includes a clip configured to support the workpiece in the target position; and

the sensor is translated to the predetermined location when the sensor is in contact with a portion of the clip.

12. The apparatus of claim 9, wherein

the predetermined location is coincident with the target position; and

the predetermined increment is null.

13. The apparatus of claim 9, wherein the loader is further configured to:

translate the sensor by a first predetermined distance at a first speed from an initial location to a location in closer proximity to the predetermined location; and

translate the sensor to the predetermined location at a second speed when the sensor is at or past the location in closer proximity to the predetermined location.

14. The apparatus of claim 13, wherein the first speed is faster in comparison to the second speed.

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